Keys to Subcontracting Space Hardware with JPL

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Abstract— **The Jet Propulsion Laboratory's (JPL), process of subcontracting space systems and hardware with suppliers varies somewhat from the industry-standard supply chain process. This paper is an overview of the contracting process with JPL, a division of the California Institute of Technology (Caltech), in Pasadena, CA.**

The goal of this paper is to present and clarify the JPL way of subcontracting in order to help both current and potential suppliers understand the JPL nuances and ease their process of contracting with JPL.

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1. INTRODUCTION

JPL is a uniquely positioned entity of NASA. JPL maintains a "Prime" contract with NASA. It has a dual character; it is a federally funded laboratory and unincorporated subdivision of Caltech. Caltech manages JPL and the JPL Director, a Caltech Vice-President, reports to the President of Caltech. JPL in turn, leverages Caltech's creativity, innovativeness and excellence.

"Caltech pioneers audacious science and technology that transforms the world". - *Caltech*

JPL's application of Caltech's expertise is apparent in the well-known success of their flagship Solar-System Spacecrafts, numerous Mars landers and rovers, and Earth Remote Sensing satellites.

The subcontracting areas of interest presented in this paper include:

1. Define JPLisms and keys to contracting.
2. Describe the JPL acquisition process steps from RFP to award through execution and contract closure.
3. Clarify the JPL organizational structure and its roles and responsibilities.
4. Specify JPL interface contacts for business and technical issues.

2. JPL TERMS

Titles and Acronyms

JPL incorporates terms somewhat different from the Aerospace industry standard. JPL has retained their unique terms in preference to more traditional industry terms. Some roles are clearly different and some are just the JPL way. For new suppliers to JPL, this can be confusing. The participant's roles are generally the same but JPL divides the responsibilities and uses different titles. Table 2.1 defines some common terms.

Table 2.1 Personnel titles.

Aerospace Industry	JPL
Program Manager	Project Manager (refers to overall program manager)
Material Program Manager (MPM)	Contract Technical Manager (CTM)
Subsystem Manager	Product Delivery Manager (PDM)
Subcontract Manager	Subcontract Manager (SCM)
Business Manager	Business Administration Manager (BAM)
Mission Assurance Manager or CSO	Mission Assurance Manager (MAM)
Lead Engineer	Cognizant Engineer (CogE)
Specialist Engineer	Subject Matter Expert (SME)

978-1-5386-6854-2/19/$31.00 ©2019 IEEE

Application descriptions.

Aerospace Industry	JPL
Contractor Data Requirements List (CDRL)	Subcontract Data Requirements List (SDRL)
Flight /Flight Critical hardware	JPL Critical Item hardware (JCI)
Procedure/Traveler	Instructions for Build Assembly and Test (IBAT)
Avoid Verbal Order (AVO)	Inner Organization Memo (IOM)
Engineering Order (EO)	Technical Direction Memo (TDM)
Contractor/Supplier	Subcontractor
Subcontractor	Lower-tier Subcontractor
Sub-order under a contract	Subcontract Work Order (SWO)

Project Lifecycle Phases

One area of commonality with industry is the JPL project lifecycle. The phases of the JPL lifecycle follow the well-established NASA lifecycle with standard gates and reviews between phases. The process is shown in Figure 1.

The JPL/NASA project lifecycle is best described by stepping thrugh the phases. Phase A typically begins with JPL's Down-Selection" to the chosen subcontractor and ends with the completed project selection.

In Phase B, the project begins and the completion gate is the Preliminary Design Review (PDR). Phase C continues the process with the Critical Design Review (CDR) and concludes with a System Integration Review (SIR). Phase D is the manufacturing process with Manufacturing Readiness Review (MRR), assembly, integration and test, and concludes with launch. Phase E is on-orbit or flight operations and concludes with decommissioning.

Organizational Structure

The JPL organization is unique. First off, JPL Director reports to the Caltech President. Secondly, under the Director are ten Directorates. These directorates are similar to industry's "Divisions".

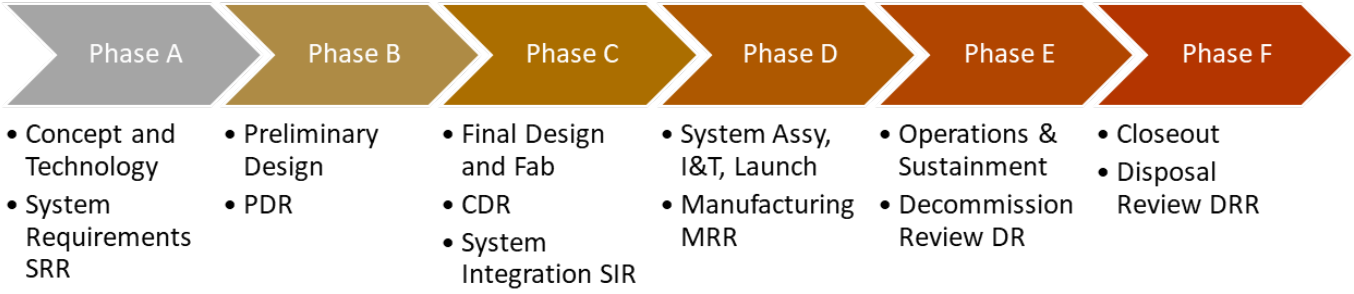

Figure 1 The JPL project lifecycle follows the NASA lifecycle.

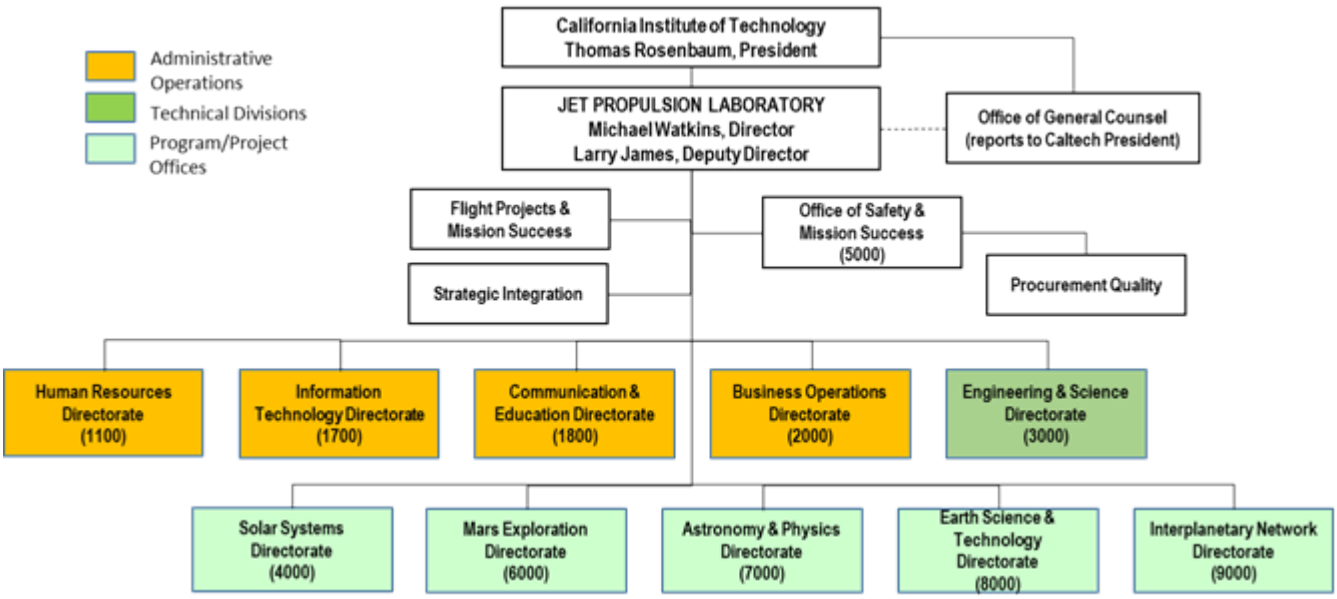

Figure 2. JPL reports to Caltech, Directorates are referenced by numbers and Program offices are matrixed with support functions.

To simplify Directorate references, they are commonly referred to as numbers. Within each Directorate are numerous Divisions. The administrative directorates are Human Resources 1100, IT 1700, Communication and Education, 1800 and Business Operations 2000. Business Operations contains both Acquisition and Finance. Engineering 3000 is the largest directorate or as is commonly referred to as 3X.

Figure 2 shows the overall JPL organization chart.

The JPL Program offices are organized into five Directorates determined by their type of mission. These are:

1. Solar System 4000
2. Mars Exploration 6000
3. Astronomy & Physics 7000
4. Earth Science & Technology 8000
5. Interplanetary Network 9000

Support to the Program Directorates is matrixed from the other Directorates. As an example, a supplier's contract representative may interface with a Subcontracts Manager and a Finance Manager from 2000, a contract technical manager from 3000 and a Mission Success representative from 5000.

3. PROJECT ACQUISITION AT JPL

Compared to industry, JPL has no so-called "Supply Chain" department. In the place of a Supply Chain department, JPL subcontract management is accomplished through a careful partnering between the Acquisition organization and the Technical discipline organizations.

The Acquisition Division of the Business Operations Directorate manages the contractual obligation in regards to proposals and active subcontracts. The Finance Division, which is also within Business Operations, assists Acquisition by managing the costs and funds of the subcontracts. Acquisition and Finance partner with the Engineering Directorate. Engineering manages the subcontract technical obligations, requirements and approvals.

All JPL Flight and Ground System projects execute a project acquisition process, including individual instrument projects. Hardware, electronics and software procurements span across all phases of the life cycle from concept to closure. The JPL Project Manager is ultimately responsible for the deliverable and the finance and acquisition divisions assist the project to enable this.

Behind-the-scenes initial steps performed at JPL include make-buy decisions, partner agreements, acquisition plans and long lead procurements. Procurements estimated to be valued over $25K require competition to the "maximum practical extent," as required by the Prime Contract with NASA.

JPL executes missions in one of three modes: In-house, where JPL performs all aspects of the mission; System contract, where JPL procures spacecraft (S/C) from industry, or Mixed-mode Partnered, where JPL and industry share development.

JPL designates all project work into levels from the top level being Flight Systems, to Instrument, to Subsystem, to Assembly, or Lower (e.g. components) configurations.

JPL defines qualified suppliers under two ratings: 1) responsive and 2) responsible. Responsive suppliers are those who submit proposals that are submitted by the

required deadline and address and meet all requirements of the solicitation. Being responsive also means they agree to comply with the material aspects including Terms and Conditions (T&Cs) and specifications. Responsible suppliers are those who are capable and have proven themselves capable of meeting the requirements and producing what is proposed. A supplier proposing the "best value" is not always enough. Responsible suppliers are evaluated on their capability of performing the effort and their past performance.

The Acquisition Process

The JPL acquisition process is composed of seven phases shown in Figure 3.

Figure 3. JPL's seven phases map the acquisition process from concept to closeout.

The process begins with Phase 1&2 Solicitation. In Phase 1, JPL develops the acquisition plan, the requirements and the approach or Statement of Work (SOW). Then in Phase 2 of Solicitation, JPL issues a Request for Proposal (RFP). Contract types are either Fixed Price or Cost-Type. Fixed Price include Purchase Orders (POs), Cost-Types include Cost Plus Fixed Fee (CPFF) and Cost Reimbursement (CR) subcontracts.

In response to the RFP, the subcontractor(s) submit a technical and cost proposal to JPL. A complete proposal is expected to address each item within the SOW with technical and cost information. The proposal must be submitted by the due date specified in the RFP, otherwise a late proposal is deemed non-responsive. See Section 5 for details on the RFP and Proposal process.

Next is Phase 3, Evaluation and Source Selection. In this phase, JPL technical personnel perform a technical evaluation of the submitted proposal. Each step of the SOW is reviewed for reasonableness of labor and phasing. Tasks are reviewed for completeness and correctness. JPL may request additional information from the supplier during the review. In turn, the supplier timely provides the requested information or clarification.

Subcontract are awarded only to firms that have the financial, management, and technical resources to reasonably perform the subcontract according to its terms and conditions.

Phase 4 begins the Award Activities Phase. At this point, JPL confirms the previously established contract type against the contract risk and reclassifies it if needed.

If an item is a Commercial off the shelf (COTS) purchase and the item is not competed, this process may simplify to the Subcontract Manager requesting price justification. The supplier's Contracts department personnel works with the SCM until an agreement is reached between the parties.

In Phase 5, the Approval phase, JPL approves funds for commitment to the subcontract. This step takes time and involves the Acquisition Planning and Compliance Section (APCS). A standard template and T&Cs is used, and if extensive modifications are needed, the Office of General Counsel (OGC) and the NASA Management Office (NMO), may become involved. Following internal approval, the SCM executes the contract.

Once the subcontract is in place, Subcontract Management Phase 6 begins. This phase runs through to delivery. JPL manages the subcontract and closely monitors the cost, schedule, and SDRLs of all deliverables. JPL requires tracking of all supplied material or Government Furnished Property (GFP) (which includes flight and non-flight items) and Mechanical Ground Support Equipment (MGSE) transportation and delivery. In return, the subcontractor is on contract to hold any planned reviews (ex. PDR, CDR, MRR, TRR), contact QA for any agreed-to Manufacturing Inspection Points (MIPs) and submit on-time SDRLs (Plans, Procedures, 533s, financial reports, waivers).

If any issues arise during this phase, the subcontractor is required to notify JPL immediately. If this results in a change to the subcontract, JPL initiates a Contract Modification. JPL will develop a SOW and define technical requirements for the task, and issue a RFP. The modification may be either in the form of a subcontract modification or as a separate order under the subcontract or Subcontract Work Order (SWO). Both modification methods are then negotiated (if there is a cost impact) and the subcontractor is placed on contract. As the subcontract progresses, this can be an iterative process.

After delivery of all deliverables to JPL is complete, the Closeout phase begins. The subcontractor presents all

closeout paperwork and final deliveries. JPL verifies all work completion and all deliverables have been received. JPL verifies all GFP has been accounted-for and dispositioned. The subcontractor tracks and collects the GFP and as directed, and either returns it to JPL or disposes of it at JPL's direction.

The JPL phased acquisition process clearly defines the requirements and qualified sources that lead to and execute a subcontract from concept to delivery.

4. JPL TO SUBCONTRACTOR INTERFACE

The question may arise about "who-to-call" at JPL. The structure of the JPL acquisition system is different from the standard industry format in that there is no single point "Supply Chain" division. This may at first be confusing. Instead, the JPL system incorporates a two-person team. The Contract Technical Manager (CTM) and a Subcontract Manager (SCM) collaborate to manage the contract and technical requirements, and perform a check-and-balance system that assures the correct goals are both established and met.

The CTM and SCM are the JPL interface to the subcontractor. They manage the conduct of work in accordance with JPL institutional directive, programmatic project documents. Their job is to verify the subcontractor's performance of acceptable programmatic actions in their respective fields: technical aspects for the CTM, business relationship for the SCM, and a combined ownership of the business and programmatics of the subcontract. Figure 4 describes how their roles overlap with respect to the subcontract.

The CTM is the technical lead and focal point for all technical work and aspects on a subcontract. They have specific responsibilities to the JPL organization to ensure implementation of the contractual technical obligations.

The CTM executes their responsibilities with support from function relationships. The CTM draws on the JPL organization for technical and programmatic assistance and maintains communication with all participants. Besides the relationship with the SCM, the CTM is the main technical interface with the supplier's Program Manager and Engineering Manager. Although the CTM's direct line of report is their functional manager, they are accountable to their Product Delivery Manager (PDM), and the JPL Project Management and Office. They draw support from their internal team of Project Engineers and Subject Matter Experts (SMEs) in all fields of interest related to the deliverable. Their goal is successful delivery and acceptance of the required products and services.

The SCM is the financial and subcontract lead for all contractual obligations and is the only employee authorized by Caltech to commit JPL financially and contractually. The SCM manages and executes all subcontract modifications or changes, and not the CTM.

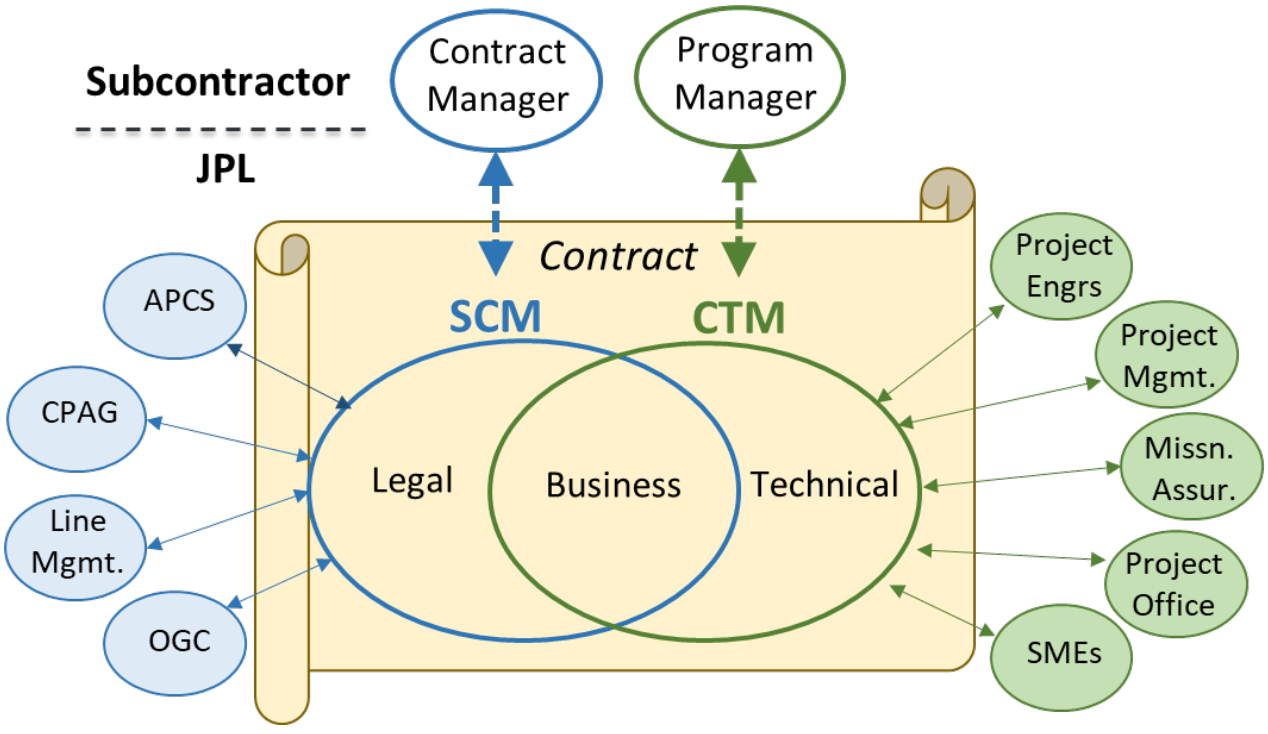

Figure 4. JPL Subcontracts management is accomplished through a coordinated partnering between the Acquisition organization and the Technical discipline organizations.

The SCM interfaces with the CTM on all business issues. The SCM is the main point of contact with the subcontractor's Contracts Manager. Within JPL, the SCM reports to their functional management. They interact with the JPL Acquisition Planning and Compliance Section (APCS), Cost and Performance Analysis Group (CPAG) and occasionally the Office of General Counsel (OGC).

As part of their job, the SCM makes the determination that the subcontract is awarded to a qualified subcontractor. A CTM may request a Technical Directive Memo (TDM) be sent to the subcontractor for technical clarification within the scope of the contract. The SCM issues the TDM to the subcontractor.

The SCM and CTM partner in establishing and maintaining a positive, beneficial partnership between JPL and the subcontractor, which extends to the interactions between JPL and subcontractor personnel, and encourages excellence in accomplishment of the subcontract objectives.

5. PROCUREMENT REQUIREMENTS

Request for Proposal (RFP)

The CTM and SCM work together to develop a RFP to submit to the subcontractor. The following is JPL's four-step process for developing an RFP.

Step 1: JPL management and support functions develop an Acquisition, Mission Assurance, Project and a Risk Plan.

Step 2: The CTM and SCM review the plans. The CTM leverages all appropriate disciplines and develops a SOW detailing the project, tasks, delivery items and dates, JPL provided items, inspection, program management, reviews and payment provisions.

Step 3: The CTM develops the technical requirements, design and construction, SDRLS and quality assurance provision. These are either placed in separate documents (i.e. technical specification), or added to the SOW depending on the extent of the task.

Step 4: The CTM and SCM review the SOW for completeness and accuracy. The SCM combines the SOW with the attachments and submits a RFP to the subcontractor.

Note: POs for COTS or other commercial or non-research and development purchases may have a SOW combined with technical requirements and deliverables (SDRLs).

For POs, a Request for Quote (RFQ) is issued to a subcontractor. With subcontracts, a Request for Proposal (RFP) is issued. Once JPL issues a RFQ or RFP and sets a due date, it is the responsibility of the subcontractor to deliver a thorough proposal. The most important item is to address and cost each item within the SOW. Having each item addressed is the only way JPL can objectively evaluate each proposal. During the proposal phase, the subcontractor is welcome to contact the SCM to clarify questions or request further information on what JPL expects for a task. Sometimes tasks are revised based on better understandings. The subcontractor may not contact anyone but the SCM during the proposal phase. The SCM will consult with the CTM as necessary to respond to any subcontractor questions.

SDRLs

One area of a subcontractor concern in generating a proposal is the large number and many types of Subcontract Data Requirements List (SDRL) and Design Requirements Document (DRD) that JPL requests. These are easy to understand. The structure mirrors the military structure.

JPL has a standard format for SDRL submittals that identifies the items to be delivered, when delivery is required, and the frequency of issue.

The accompanied DRD describes specific requirements for the item to be delivered.

- The standard SDRL list is tailorable for each project and subcontractors may take exceptions to some based on their standard processes.
- JPL to provide approvals to submitted SDRLS within 20 working days or may be approved by default. Waivers may remain open until closed.
- SDRL categories include:
  - Configuration Management (CM)
  - Environmental Requirements (ER)
  - Mission Assurance (MA)
  - Mission Operations (MO)
  - Procurement (PR)
  - Reviews (RE)
  - Resource Management (RM)
  - Systems Engineering (SE)
  - Software (SW)
  - Technical Documents (TD)
  - Integration, Test and Verification (TE)

Significant PR subcontract reports include:

1. New Technology Reports
2. Subcontractor Property & Vesting Authorization Form 7112
3. Contractor-Held Asset Tracking System (CHATS) Report
4. Property in the Custody of Subcontractors
5. Annual Results of Inventories
6. Small Business Subcontract Reports
7. Copyright Releases

Significant General RM financial reports include:

1. Financial Management Reports
2. Resource Management Data
3. Work Breakdown Structure and WBS Dictionary
4. Project Schedules
5. Earned Value Management (EVM) Plan

6. Integrated Baseline Review (IBR) Data Package
7. Cost Performance Reporting

The SDRL may seem like a lot of documents, and it is. It can and should be tailored for each subcontract. For less complex subcontracts, reports can be minimized, due dates revised, and meetings changed to teleconferences. JPL allows for flexibility, within reason, in adjusting to a company's standard processes.

7. SUMMARY

The JPL subcontract process may at-first appear complex. This paper's goal is to explain the steps, organization, terms and personnel involved in subcontracting with JPL. A sort-of who-to-contact list and "what-can-I-expect" information.

The acquisition process steps flow in a logical sequence with set expectations for each party. Acronyms are always confusing until explained, and JPL's are no exception. Even JPL's role in the NASA community is different as a center under Caltech with Directorates named for space categories.

Once a subcontract is in place, the key interface is not a single-point supply chain subcontract but rather a joint interface with the SCM and CTM. Lastly, JPL SDRL deliverable list may seem endless, but in working together, it may be reasonably tailored.

The JPL acquisition process' highly structured appearance is to maintain and support the JPL-Caltech reputation for audacious science and technology. This paper's goal was to simplify the acquisition process and assist the technical community in understanding and successfully working with the JPL.

APPENDICES

A. ACRONYMS

Table A. JPL Acronyms used in this paper.

Acronym	Description
APCS	Acquisition Planning and Compliance Section
BAM	Business Administration Manager
Caltech	California Institute of Technology
CDR	Critical Design Review
CHATS	Contractor-Held Asset Tracking System
CM	Configuration Management
CogE	Cognizant Engineer
COTS	Commercial off the shelf
CPAG	Cost and Performance Analysis Group
CPFF	Cost Plus Fixed Fee
CR	Cost Reimbursement
CTM	Contract Technical Manager
DRD	Design Requirements Document
ER	Environmental Requirements
EVM	Earned Value Management
GFP	Government Furnished Property
IBAT	Instructions for Build Assembly and Test
IBR	Integrated Baseline Review
IMO	Inner Organization Memo
JCI	JPL Critical Item hardware
JPL	Jet Propulsion Laboratory
MA	Mission Assurance
MGSE	Mechanical Ground Support Equipment
MIP	Manufacturing Inspection Point
MO	Mission Operations
MPM	Material Program Manager
MRR	Manufacturing Readiness Review
NMO	NASA Management Office
NVBD	NASA Vendor Database
OGC	Office of General Counsel
PDM	Product Delivery Manager
PDR	Preliminary Design Review
PO	Purchase Order
PR	Procurement
RE	Reviews
RFP	Request for Proposal
RFP	Request for Proposal
RFQ	Request for Quote
RM	Resource Management
S/C	Spacecraft
SCM	Subcontract Manager
SCM	Subcontract Work Order
SDRL	Subcontract Data Requirements List
SE	Systems Engineering
SIR	System Integration Review
SME	Subject Matter Expert
SOW	Statement of Work
SW	Software
SWO	Subcontract Work Order
T&Cs	Terms and Conditions
TDM	Technical Direction Memo
TDM	Technical Documents
TE	Integration, Test and Verification

B. MORE INFORMATION

For more information on the JPL Acquisition, visit the Web site at: https://acquisition.jpl.nasa.gov/

For more information contracting with NASA, visit the NASA Vendor Database (NVDB) at: https://osbp.nasa.gov/vendor_database.html

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

REFERENCES

[1] IEEE Aerospace Conference Web site: www.aeroconf.org

BIOGRAPHY

Susan Pasko Heuchert *(pronounced Hikert) received a B.S. in Mechanical Engineering from California Polytechnic, San Luis Obispo and a M.S. in Systems Management from the University of Southern California, Los Angeles. She has been active in the Aerospace Industry on both the delivery and receiving ends of business managing projects for more than 25 years. She is currently a CTM/CogE on Mars 2020 managing the Aeroshell subcontract. Previously she was Deputy Program Manager at Astro Aerospace on the SMAP Imager as a subcontractor to JPL, and a Lead I&T Engineer at Raytheon SBRS developing numerous imagers including MODIS Terra for NASA, JPSS and the On-Orbit Program Manager for Landsat VI & VII.*